Ship performance evaluation and clean energy ship type scheme under complex channel conditions

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ABSTRACT

In order to improve the interaction and adaptability between ships and complex waterways, this article takes a typical Wujiang 1000-ton cargo ship as an example, using theories and numerical conversion methods such as ship dynamics and maneuverability, to evaluate and analyze its adaptability to waterways from the aspects of ship resistance, maneuverability, and energy efficiency indicators. Obtaining better performance index results suitable for ships under current channel conditions Finally, a clean ship type technical scheme with excellent comprehensive performance is proposed.

KEY WORDS: High velocity and large gradient inland waterway, Ship seaworthiness assessment, Clean energy ship type scheme.

INTRODUCTION

Inland navigation is of great significance to the development of the national economy. With the completion of cascade development and a series of shipping construction projects, the conditions of China's inland waterway have been greatly improved. However, after channelization, China's inland navigable waters have the dual attributes of reservoir channel and mountain channel. The navigation conditions of different sections vary greatly in different seasons, and the local sections or backwater variation sections have the characteristics of large flow velocity, large gradient, shallow channel, and small radius of curvature, resulting in small load of ships sailing in such key sections; The resistance performance and maneuverability are poor, the navigation safety is insufficient, and there are potential safety hazards. The comparative advantages of inland navigation such as large transport capacity, low cost, low energy consumption and light pollution are not fully played. At present, the interaction and adaptability of ships and complex channels is also an important manifestation of the efficiency of ship operation, so it is important to explore the adaptability of navigable ship types and complex channels.

Therefore, this paper takes a typical Wujiang 1000-tonnage cargo ship as an example, uses appropriate methods to carry out the assessment and analysis of the adaptability of ships in key sections, and proposes a green ship type technical scheme that is suitable for the complex channel conditions in key sections of Wujiang River and has excellent comprehensive performance.

1.COMPREHENSIVE ANALYSIS OF CHANNEL ENVIRONMENT AND FLOW CHARACTERISTICS OF WUJIANG RIVER

1.1 Navigation environment analysis

In recent years, the development and construction of hydropower projects have been combined with channel regulation measures, and the channel grade of river reaches has been improved. Currently, the mileage of the Dugongtan section of the Wujiang River in Guizhou Province is 407 kilometers, and the mileage of the tributary Qingshui River is 24 kilometers. A total of 431 kilometers of waterway regulation has been completed. The whole line of Wujiang River will reach the new class I waterway standard, which can meet the passage of the new generation of 1000 ton green and efficient ships in Wujiang River.

The channel conditions of Wujiang River in Guizhou Province include two navigation scenarios: backwater variation section and reservoir area, most of which are reservoir area, and a few are backwater variation section (Wang Zairong, Lei Fei,2021). Considering that the backwater variation section is characterized by natural channel, and the beaches are numerous and the water is urgent, higher requirements are put forward for the power and maneuverability of the new generation of Wujiang 1000-tonnage green high-efficient ships. When the ships adopt the relevant clean energy power technology, they should ensure that the ships have sufficient power response.

In terms of navigation facilities, the existing navigation facilities of Wujiang Waterway include ship lock, ship lift and the combined hub of ship lock and ship lift. The planned navigation hub is a combined hub consisting of the approach channel, ship lock, navigation tunnel and ship lift. The constant water depth of vessels in the tunnel is 5.5 meters. The navigation tunnel is arranged in a straight line, with a flat bottom slope and a one-way traffic tunnel, regardless of the passage and docking of ships within the tunnel. It can be seen that the ship is sailing in the restricted closed water area with small section in the navigation tunnel, and there are relatively many tunnel voyages in the whole voyage. Since the operation mode of ships in the tunnel is still uncertain, and the self-navigation of ships in the tunnel can reduce the construction cost of the project(Sun Jingshi,2006).

1.2 Flow characteristics and water depth conditions of the route section